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An Artificial Intelligence Enabled Clinical Decision Support System In Mental Health Disorder

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Abstract
Mental health disorders contribute for more years 'lived with disability' (YLDs) than any other health problem today, with about 30% of all persons experiencing a mental health disorder during their lives. A medically diagnosed mental health issue affects over half of the population at any given moment. Despite this, only about a third of people with mental illnesses in the world receive the treatment they need. Failure to receive a quick diagnosis and proper early management for neuropsychiatric disorders increases the chance of comorbid mental health issues as well as behavioural issues. However, computers or, to be more accurate, clinical decision support systems need to do the majority of this work. A clinical decision support system (CDSS) is a cutting-edge computer programme that aids medical workers in making decisions while treating patients. CDSS provides real-time information and recommendations to doctors based on established clinical guidelines and vast data sets. The CDSS is a system for diagnosing and treating mental diseases. The goal is to increase the integrity, expertise, and efficacy of mental health services (MHS). This article examines how these strategies can aid clinicians to make better, faster, and more accurate judgments.

Keywords: Clinical decision control system, mental health disorder, diagnosis.

Introduction
Lack of access to essential mental health services (MHS) has a significant impact on the health of patients and their families, but it can also be detrimental to society. Long-term mental health concerns can result from misdiagnosed or untreated mental health issues, demanding long-term treatment. Those with mental disorders take more leave from work and contribute less, therefore undiagnosed or untreatable mental illnesses are also detrimental to society's future employment market and economic viability. Yearly, MHS treats over 40% of the patients with specialised care. Introducing information and communication technologies (ICT) into MHS quality assurance, such as clinical decision support systems, is one novel technology that has the capability to be both economical and long term sustainability.

A clinical decision support system (CDSS) is a computational system that gives physicians real-time guidance as they provide services to patients based on existing evidence. A CDSS uses scientific proof data to generate clinically important standards and guidelines to allow clinicians properly assess the requirements of individual patients. CDSSs are not intended to be an option for health carers. A CDSS typically has three components: a Clinical

Knowledge Base (consisting of guidelines and data of health domain), a Reasoning Engine (cloud-based organisation with patient's electronic health record (EHR), and a User-Interface (digital alerts and instructions in response to clinician queries). CDSS model designs can change while using recognised clinical criteria (e.g., DSM-V or ICD-11) and/or pooled health records. By converting computational guidelines into web ontology language, a CDSS uses digital models as the fundamental tool for clinical guidance. CDSSs that are "data-driven" use algorithms and data analytics to reveal patterns in care trajectories that are relevant to the patient in question. This dual technology have their benefits, a model that is with guideline-based as well as data-driven gives the physician digital generated database that is tailored in every patient based on extensive study and previous patient cases.[1] While CDSS implementation definitely increases service quality in general medicine, there is no evidence that CDSSs can improve MHS. One reason for the restrictive research is limited permission to psychiatric data. However, most existing data in MHS have highlighted several shortcomings, including a lack of integration with the EHR, limited diagnostic prediction models, and poor inclusion of numerous illnesses.[2]

The study design and methodology for the first CDSS for MHS are presented in this paper. It is a cutting-edge research effort that will benefit Health, Care, and Welfare Services. CDSS's ultimate goal is to improve patient care by providing practitioners with real-time, data-driven, and evidence-based information that allows for quicker and more accurate decision-making, eliminates wrong diagnosis, and lowers inefficiencies in patient care procedures. The study's main purpose is to see if real-time decision support for physicians during clinical sessions might improve clinical care. The purpose of the review is to determine the clinical utility of CDSS in the diagnosis and treatment of mental illnesses.[3]

Mental Health

According to WHO (World Health Organization) mental health is "a state of well-being in which every person recognises their own maximum capabilities, copes with ordinary life challenges, works imaginatively and productively, and contributes to their society." This notion emphasizes that mental health nothing but the condition of being not suffering from mental illness.[4] Mental illnesses, also known as mental diseases, involve diverse categoties of difficulties and symptoms, according to the WHO, which are often described by a combination of weird thoughts, emotions, behaviour, and personal relationships. Mental diseases are on the increase in developing countries. According to studies, around half of the patients admitted to primary care clinics have psychiatric problems. Mental disorders are associated to disfunctioning in occupational, social or familial activities.[5] To put people into one of six groups, the entire mental health concept blends mental wellbeing with the relative importance of psychological disorder. Both flourishing and the truancy of mental disease are included in mental health. Limitations in everyday activities, missed work days, physical issues, and increased use of acute health care services and prescription medicines have all been linked. [6,7,8]

Electronically developed records for patients health are generally available, but they rarely provide enough understanding of the complex clinical circumstances that are typical in psychological treatment, such as how to successfully address newly identified genetic underpinnings for disorders. [9] They are computerised systems that help people make difficult decisions and solve problems. CDSS's main purpose is to help decision-makers design and investigate the repercussions of their actions.[10,11] CDSS is gaining in popularity around the world. CDSS offers advantages including automatic examinations, outcome measures, and monitoring of defined parameters. The CDSS aids in decision-making but does not make any decisions; the clinical

expert's input is crucial to the decision-making process. [12]

A CDSS evaluates huge amounts of data at each step in the clinical decision-making process, then uses algorithms to correlate patient situations and phenotypic characteristics to some of the most appropriate options, in order to give the most necessary details and alternatives. The job of practitioners is not taken by a CDSS. Its goal is to deliver the greatest possible, personalized, actual help to professionals. [13,14]

"Active knowledge systems that produce case specific recommendations from two or more bits of patient information" are what Clinical Decision Support Systems are. All clinical decisions are tough in general, but owing to their abstract nature, psychology or mental ailments are the most difficult to diagnose and treat when compared to other aspects of health care. Looking at current developments, it's clear that the trend in psychiatry is to develop new computer-assisted decision-making tools and evaluate them in practice.[15]

CDSS architecture

CDSS is a computer application that aids clinicians in reaching treatment decisions. The notion is not new in medicine: the first CDSS, MYCIN, was built at University of Stanford during 1970s. To detect contagious infections and give proper therapy, it deployed an model of an artificial intelligence with over 600 rules. It has highly skilled medical professionals in terms of judging correctness, but still it was never used practically because of ethical and regulatory problems. The idea of a machine serving as health expert was far too radical to pass muster. In hospitals, CDSSs are utilised for a variety of tasks, including alert generation, drug control, and test scheduling. There are many different types of decision-making software. They can be standalone programmes or integrated into larger infrastructures, such as an Electronic Health Record (EHR) or a system that substitutes paper-based ordering. Some of them focus on one point at a time and perform modest duties such as making suggestions. Others have a lot of modules and cover a lot of procedures.

Regardless of their size, modern systems benefit from powerful computing engines, cloud technology, and smart algorithms. In recent years, they haven't changed much in terms of architecture, maintaining structures that are analogous to prior expert solutions.

A CDSS typically consists of three layers: the base or data management layer, the inference engine or processing layer, and the user interface.

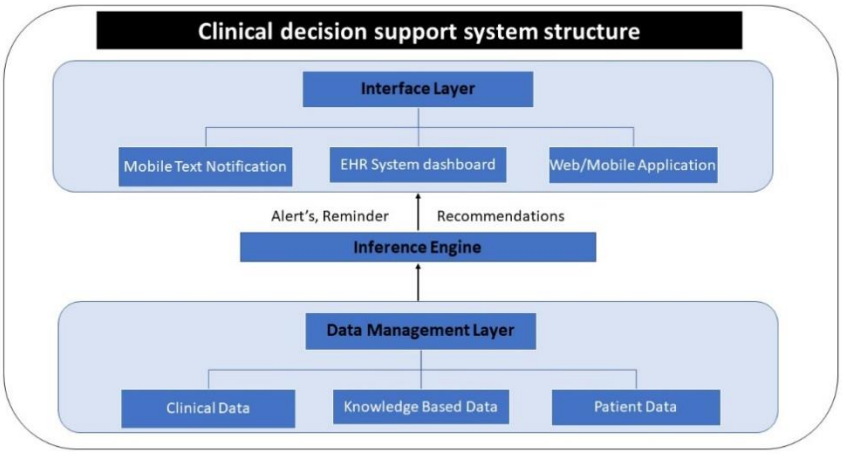

Fig. 1: Core modules of a typical clinical decision support system.

A data management layer combines:

- a clinical database that stores information on diseases, diagnoses, and lab findings;
- patient data; and

- a level of expertise that takes the form of if-then rules or machine learning models.

A processing layer or inference engine applies rules or algorithms from the knowledge base to accessible patient data. A user interface layer – a mobile, online, or desktop application, an EHR system dashboard, or mobile text alerts — displays the results.

While maintaining the similar structure, CDSSs differ in how they arrive at a decision, falling into two categories: knowledge-based and nonknowledge-based.

Knowledge-based CDSS:

This type of CDSS is developed on top of a knowledge base in which each database is structured using if-then rules. Duplication can conceivable, for example, if a fresh blood test order is placed and the same blood test was performed within the previous 24 hours.

The built-in logic of the inference engine is used to combine evidence-based criteria with the people's clinical history and current condition data. [16]

Nonknowledge-based CDSS

The core difference from the previous group consists of applying machine learning models. Rather than consulting with a library of predefined if-then rules, such a system learns from past experiences and finds patterns in historical data. These are the two techniques most widely used in such CDSSs:

- Genetic algorithms (GA), which are based on Charles Darwin's natural selection mechanics. GAs always provide a novel work by providing a variety of random solutions and then iteratively evaluating and refining them until the most appropriate alternative is determined, just as creatures change from generation to generation to better match their environment.
- Artificial neural networks (ANN) that mimic human thinking. Similar to human brains, ANNs have a set of "neurons" called "neurods." They are linked to each other with weighted connections that act as nerve synapses transmitting signals across the neural network.

Nonknowledge-based solutions have the potential of decreasing healthcare expenditures rapidly while also relieving demand on medical professionals. However, there are obstacles to their widespread acceptance. They include a time-consuming and computationally complex training process, as well as the necessity for huge datasets to increase model accuracy. The major hurdle is interpretability, as computers are unable to explain the reasons behind created conclusions. Latest models are mainly based on knowledge database due to the disadvantages outlined.[21-23]

CDSS's challenges and potential drawbacks

CDS systems help to improve healthcare, but they come with its own set of dangers and cons. To determine which decision support system will provide the most value to a specific medical institution, consider the issues those early adopters of the technology experience.

Alert fatigue: A CDSS may produce a very large amount of warnings and suggestions. As a result, caretakers begin to dismiss them, regardless of their significance. Check to see if the solution you choose includes a method for selecting and prioritising crucial notifications.[17]

Collaboration problems: Even if it has all of the necessary features, a CDS solution will be useless if it is not integrated with the existing information system. Check to see if the solution is compatible with the EHR or if it can be integrated into the workflow quickly. [18]

Limited interoperability: Clinical decision solutions may fail to interact successfully with other modules even after being integrated into the hospital IT environment because of limitations of record of health databases. Fortunately, with the widespread use of 'Fast Healthcare Interoperability Resources' (FHIR), the most recent format for interchanging and sharing healthcare data, the situation is continually improving. Many EHR providers

and medical organisations are already using it. The protocol should be embraced at all levels of a healthcare organisation, as well as by any external systems you want to employ, to ensure easy data transmission. [19]

Adoption costs: The end-to-end CDSS operation requires large expenditures. The overall adoprion cost will be significantly increased by customization and integration with existing infrastructure. If you're on a budget, look for options that have a modular structure and adjustable settings so you can create your system piece by piece and customise it to your needs. [20]

Application of CDSS in Mental Health

A number of medical expert systems or CDSS's have been developed to address problems in health care, but there are only few clinical decisions support systems for psychological issues.

1. In this study, Fathi S et al. used an ANFIS (Adaptive Neuro Fuzzy Inference System) to replicate a DSS for assessing Social Anxiety Disorder (SAD). SAD is the common psychic condition, and it is defined by a continuous and intense fear of humiliation in social situations or society. The ANFIS is an artificially intelligent technique that learns a system by combining the advantages of both neural networks (NN) and fuzzy logic approaches. This study utilized relevant features to create this system for social phobia diagnosis. Pre-processing, categorization, and assessment were the three processes. The three steps of initial processing phase were normalization, selection of features, and anomaly detection. During the normalization stage, all of the characteristics were rescaled to 0-10 values. In the feature selection process, IBM SPSS Modeler software V18.0, which is a data analysis to selected seven top-rank features. The ANFIS method having five times validation check was used to categorize social anxiety disorder, obtaining a highest accuracy of 98.67%. Although artificial intelligence, namely the ANFIS technique, has been utilized for the detection of a variety of mental illnesses, including depression, the authors are unclear if it has been used for SAD diagnosis. [24]

2. Psychiatric issues are quite frequent, and they can cause considerable delays in healing and necessitate costly studies before a diagnosis can be made. There are a few common issues with developing CDSS. The goal of this project is to use this system to diagnose mental issues. A multimodal decision support system can be used to identify psychiatric issues among patients. Suhasini and co-workers introduced a multi-model system for mental diagnosis. The DSS was created using a hybrid technique that integrated Back Propagation Neural Network, Support Vector Machine and Radial Basis Function Neural Network. For detecting mental issues, the method had a highest success rate of 98.75 percent. [25]

3. Windriyani et al. proposed an expert system for diagnosing mental diseases using the forward chaining approach. This is a sort of computer-based information system that makes high-level choices rely on expert understanding in a narrowly defined subject area. This indicates that a medical professional can use an expert system to address a problem as if he or she were a psychiatrist. They used the MINI ICD-10 (Mini International Neuropsychiatric Interview) version of ICD-10 as a tool to construct the procedure with the support of professionals. Despite the system's reliance on expert knowledge, its accuracy was 96 percent, which appears to be enough. [26]

4. The goal of the scientist's work on simulation of human behaviour and study of anxiety among students and its influence on behaviours is to construct an ANFIS model from numerous sources of information and compare its performance to Sugeno FIS in predicting students' anxiety levels. The fuzzy logic method is an intelligent computer technique that may be used to solve majority of issues. Their capability to articulate relationships between variables of output and input has been established. Anxiety is influenced by neuroticism and extraversion, hence these two are used as input factors. Using the questionary developed with Moudsley

personality inventory combining with comprehensive anxiety test designed by sinha, the approach begins with information acquisition for neuroticism and extraversion. The performance of the ANFIS model is further evaluated using the average absolute % error and root mean square error methods. [27]

5. Trivedi et al. introduced an evidence-based CDSS for the diagnosis of major depressive illness. CompTMAP is a CDSS for the treatment of depression or other mental diseases that was created at the Texas University's Southwestern Medical Centre. It is a computerized therapy algorithm for psychiatric conditions like depression that may be used by psychiatrists as well as primary care practitioners. The TMAP was a comprehensive study that compared standard treatment in the social mental health sector to prescription medication methodologies combined with clinical support and a patient-family educational package in the treatment of patients with one of 3 psychiatric conditions including Bipolar Disorders, Schizophrenia or major Depressive Disorder. Physician ordering entry, alarm systems, electronic health records, and retrieval of information are all available through CompTMAP, as well as decision help in assessment, appropriate treatment options, and follow-up and wellness programs. CDSS was created to aid in the diagnosis, treatment, and prevention of disease. Later, researchers looked at the hurdles of the CDSS method for depression in real-world clinical settings. [28]

6. When Rollman et al. looked at the outcomes of an electronically generated medical record system in a healthcare setting that supplied electronic feedback to healthcare professionals in the mental health diagnosis, they observed that several family physicians agreed with the CDSS feedback diagnosis and utilized it to make treatment decisions. [29]

7. A Decision Support System (DSS) to be used in psychiatric hospitals has been created by the Harmonex Group. Harmonex's neuroscience research division covers issues such as depression, schizophrenia, bipolar disorder, ADHD, and anxiety. CliniCom DSS makes advantage of electronically generated medical records. CliniCom is a psychiatric specialist's computer-assisted intake and evaluation tool. It gathers information directly from patients, parents, and/or guardians prior to an initial assessment in order to create clinical reports. CliniComt provides professionals with unprecedented access to data about their patients' health. [30]

8. Adult ADHD (attention deficit hyperactivity disorder) is a complicated neuropsychiatric condition that affects 2–5% of adults on a regular basis. Juha Kemppinen et al. used the CDSS technique to accurately diagnose adult ADHD patients. Because of the many issues raised, Eksote employed an agile business process development technique to construct a CDSS for adult ADHD diagnosis. The CDSS combines a process management tool and a decision support system. The technology improved operational efficiencies, reliable screening tool usage throughout the organization, and gave complete transparency through robust reporting features. [15]

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